

RADIO COMMUNICATION SYSTEM, ELECTRONIC APPARATUS WITH
RADIO COMMUNICATION FUNCTION, SEMICONDUCTOR INTEGRATED
CIRCUIT DEVICE FOR RADIO COMMUNICATION, AND RADIO
COMMUNICATION METHOD

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2000-191316, filed June 26, 2000, the entire contents of which are incorporated herein by reference.

The present invention relates to radio communications and, more particularly, to a radio communication system compatible to a plurality of communication schemes, an electronic apparatus with a radio communication function, a semiconductor integrated circuit device for a radio communication, and a radio communication method.

Along with advance of the radio communication technologies, communication schemes, i.e., communication protocols and signal processing methods are being improved unceasingly. Many communication schemes have been put into practical use, but communication terminals that can be used are often limited in different regions or countries due to different communication schemes.

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radio signal, and converting the received radio signal into a reception signal; and

5 a reception signal processing unit for converting the reception signal into reception data on the basis of the extracted characteristic of the radio signal.

A first semiconductor integrated circuit device for a radio communication according to the present invention a semiconductor integrated circuit device for a radio communication, comprising:

10 a receiver for receiving a radio signal;
a radio signal characteristic extractor for extracting a characteristic of the received radio signal; and

15 a reception radio signal converter for converting the received radio signal into a reception signal.

A second semiconductor integrated circuit device for a radio communication according to the present invention a semiconductor integrated circuit device for a radio communication, comprising:

20 a demodulator for demodulating a reception signal by selecting a demodulation scheme on the basis of an extracted characteristic of a radio signal;

25 a reception communication protocol processing unit for executing a communication protocol process of the demodulated reception signal by selecting a communication protocol processing scheme on the basis of the extracted characteristic of the radio signal;

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a decoder for decoding the reception signal, that
has undergone the communication protocol process, by
selecting a decoding scheme on the basis of the
5 extracted characteristic of the radio signal.

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        receiving a radio signal;
10         extracting a characteristic of the received radio
        signal from the received radio signal;

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demodulating the reception signal by selecting a demodulation scheme on the basis of the extracted characteristic of the radio signal;

25 decoding the reception signal, that has undergone
the communication protocol process, by selecting a
decoding scheme on the basis of the extracted
characteristic of the radio signal.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio communication system according to the first embodiment of the present invention;

FIG. 2 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio communication system according to the second embodiment of the present invention;

FIG. 3 is a block diagram showing the basic arrangement of an electronic apparatus with a radio

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communication function, which comprises a radio communication system according to the third embodiment of the present invention;

FIG. 4 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio communication system according to the fourth embodiment of the present invention;

FIG. 5 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio communication system according to the fifth embodiment of the present invention;

FIG. 6 is a block diagram showing the basic arrangement of a semiconductor integrated circuit device for a radio communication according to the sixth embodiment of the present invention;

FIG. 7 is a block diagram showing the basic arrangement of a semiconductor integrated circuit device for a radio communication according to the seventh embodiment of the present invention;

FIG. 8 is a view showing the frequency bands of main radio communication schemes;

FIG. 9 is a block diagram showing the basic arrangement of a radio feature extractor according to the eighth embodiment of the present invention;

FIG. 10 is a block diagram showing the combination

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of the fifth and sixth embodiments of the present invention; and

FIG. 11 is a block diagram showing the combination of the fifth and seventh embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Preferred embodiments of the present invention will be described hereinafter with reference to the accompanying drawings. In the following description, the same reference numerals denote common parts throughout the drawings.

(First Embodiment)

FIG. 1 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio communication system according to the first embodiment of the present invention. In this embodiment, a communication terminal, e.g., a portable phone, will be exemplified as the electronic apparatus with a radio communication function.

As shown in FIG. 1, a radio reception unit 1 includes a radio signal receiver 4 for receiving a radio signal via an antenna 2 and antenna switch 3, a radio signal characteristic extractor 5, and a radio signal converter 6.

The radio signal characteristic extractor 5 extracts a characteristic from the frequency,

modulation, or the like of the received radio signal, and identifies a communication scheme on the basis of the extracted characteristic. The radio signal characteristic extractor 5 of this embodiment

5 identifies communication scheme A or B on the basis of the extracted characteristic. The extractor 5 supplies the identification result to the radio signal converter 6 and a modem/baseband reception signal processing unit 7 as a control signal S.

10 The radio signal converter 6 down-converts, e.g., the received radio signal, i.e., a high-frequency radio signal containing a carrier frequency, into a reception signal of a lower frequency, and supplies the converted signal to the modem/baseband reception signal

15 processing unit 7. The radio signal converter 6 of this embodiment selects one of a down conversion scheme compatible to communication scheme A or that compatible to communication scheme B different from communication scheme A on the basis of the control signal S upon down
20 conversion.

The modem/baseband reception signal processing unit 7 includes a reception signal input switch 8, a demodulator 9A, communication protocol processing unit 10A, and decoder 11A, which are compatible to
25 communication scheme A; a demodulator 9B, communication protocol processing unit 10B, and decoder 11B, which are compatible to communication scheme B; and a

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reception data output switch 12.

The reception signal input switch 8 supplies the reception signal output from the radio signal converter 6 to one of the demodulators 9A and 9B on the basis of the control signal S.

Assume that the radio signal characteristic extractor 5 identifies that the communication scheme of the incoming radio signal is "A". In this case, the reception signal input switch 8 supplies the reception signal to the demodulator 9A. The demodulator 9A demodulates the incoming reception signal using a demodulation scheme compatible to communication scheme A. The demodulated reception signal is supplied to the communication protocol processing unit 10A. The communication protocol processing unit 10A executes a communication protocol process of the demodulated reception signal using a communication protocol processing scheme compatible to communication scheme A. Note that the communication protocol process includes, e.g., a process for demultiplexing audio data, control data, and the like from the demodulated reception signal. The reception signal that has undergone the communication protocol process is supplied to the decoder 11A. The decoder 11A decodes the processed reception signal using a decoding scheme compatible to communication scheme A, and outputs the decoded signal as reception data.

The reception data output switch 12 supplies the reception data (audio data in this embodiment) output from the decoder 11A or 11B on the basis of the control signal S to a loudspeaker 13 directly or via a voice communication unit (not shown) including a D/A converter and the like.

A modem/baseband transmission signal processing unit 14 includes a transmission data input switch 15, encoder 16A, communication protocol processing unit 17A, and modulator 18A, which are compatible to communication scheme A; encoder 16B, communication

The transmission data input switch 15 supplies transmission data (audio data in this embodiment) input from a microphone 20 directly or via a voice communication unit (not shown) including an A/D converter and the like to one of the encoders 16A and 16B on the basis of the control signal S.

Assume that the radio signal characteristic extractor 5 identifies that the communication scheme of the incoming radio signal is "A". In this case, the transmission signal input switch 15 supplies the transmission data to the encoder 16A. The encoder 16A encodes the incoming transmission data using an encoding scheme compatible to communication scheme A. The encoded transmission data is sent to the communication protocol processing unit 17A. The communication protocol processing unit 17A executes a communication protocol process of the encoded transmission data using a communication protocol processing scheme compatible to communication scheme A. Note that the communication protocol process includes, e.g., a process for multiplexing the encoded transmission data and control data. The transmission data that has undergone the communication protocol process is supplied to the modulator 18A. The

5 On the other hand, assume that the radio signal
characteristic extractor 5 identifies that the
communication scheme of the incoming radio signal is
"B". In this case, the transmission signal input
switch 15 supplies the transmission data to the encoder
10 16B. After that, the encoder 16B encodes the incoming
transmission data using an encoding scheme compatible
to communication scheme B, the communication protocol
processing unit 17B executes a communication protocol
process of the encoded transmission data using a
15 communication protocol processing scheme compatible to
communication scheme B, and the modulator 18B modulates
the transmission data that has undergone the
communication protocol process using a modulation
scheme compatible to communication scheme B, thus
20 outputting the modulated data as a transmission signal.

25 The radio transmission unit 21 includes a radio
signal converter 22, and a radio signal transmitter 23
for transmitting the transmission signal as a radio

The radio signal converter 22 up-converts the frequency of the incoming transmission signal (low frequency) to a higher radio carrier frequency, and supplies the converted signal to the radio signal transmitter 23. The radio signal converter 22 of this embodiment selects an up-conversion scheme compatible to one of communication schemes A and B on the basis of the control signal S upon up conversion.

The radio signal transmitter 23 amplifies the up-converted transmission signal to a transmission power level, and transmits the transmission signal as a radio signal via the antenna switch 3 and antenna 2.

The communication terminal with such radio communication system extracts the characteristic of the incoming radio signal from that radio signal, and identifies the communication scheme used on the basis of the extracted characteristic. Based on this identification result, the conversion scheme of the radio signal converter 6, the demodulation, communication protocol processing, and decoding schemes of the modem/baseband reception signal processing unit 7, the encoding, communication protocol processing, and modulation schemes of the modem/baseband transmission signal processing unit 14, and the conversion scheme of the radio signal converter 22 are switched to those compatible to the identified communication scheme.

Hence, a single communication terminal can cope with a plurality of communication schemes.

Since the communication scheme used is identified based on the extracted characteristic of the radio
5 signal, and the communication scheme is switched based on the identification result, the operator need not make any troublesome operations such as switching operations or the like.

Furthermore, a characteristic is extracted from
10 the incoming radio signal, and the communication scheme is identified based on the extracted characteristic. That is, since the communication scheme is identified at the time of receiving the radio signal, circuits for executing reception processes of the incoming radio
15 signal, i.e., frequency conversion circuits, modulator/demodulator circuits, communication protocol process circuits, encoder/decoder circuits, and the like can be commonized. In this manner, according to the present invention, since the circuits can be
20 commonized, size and cost reductions of the communication terminal can be achieved.

In the first embodiment, the conversion schemes of the radio signal converters 6 and 22 are switched in correspondence with communication scheme A or B.
25 However, this process is not always necessary. This is because if the carrier frequencies of communication schemes A and B are equal to each other, down

In the first embodiment, both the receiving and transmitting sides have arrangements compatible to communication schemes A and B. Such arrangement is effective to allow two-way communications even when a partner communication terminal, a base station that relays a radio signal, or the like can cope with only one communication scheme.

20 (Second Embodiment)

Such example will be described below as the second embodiment.

FIG. 2 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio communication system according to the second embodiment of the present invention.

As shown in FIG. 2, the second embodiment is different from the first embodiment in that one of the circuit groups compatible to communication schemes A and B is selectively activated on the basis of the control signal S.

More specifically, a reception signal output from the radio signal converter 6 is supplied to a reception signal input line 24 of the modem/baseband reception signal processing unit 7. The reception signal input line 24 is connected to the demodulators 9A and 9B.

Assume that the radio signal characteristic extractor 5 identifies that the communication scheme of the incoming radio signal is "A". In this case, the demodulator 9A, communication protocol processing unit 10A, and decoder 11A are activated, while the demodulator 9B, communication protocol processing unit 10B, and decoder 11B are deactivated on the basis of the control signal S. As a result, the reception signal supplied to the reception signal input line 24 is input to the demodulator 9A, and is then input in turn to the communication protocol processing unit 10A and decoder 11A. The reception data output from the

decoder 11A is supplied via a reception data output line 25 to the loudspeaker 13 directly or via a voice communication unit (not shown) including a D/A converter and the like.

5 If the radio signal characteristic extractor 5 identifies that the communication scheme of the incoming radio signal is "B", the demodulator 9B, communication protocol processing unit 10B, and decoder 11B are activated, while the demodulator 9A, 10 communication protocol processing unit 10A, and decoder 11A are deactivated. Therefore, the reception signal supplied to the reception signal input line 24 is input to the demodulator 9B, and is then input in turn to the communication protocol processing unit 10B and decoder 15 11B. The reception data output from the decoder 11B is supplied via the reception data output line 25 to the loudspeaker 13 directly or via a voice communication unit (not shown) including a D/A converter and the like. A transmission data input line 26 is connected to the 20 encoders 16A and 16B.

 Transmission data input from the microphone 20 directly or via a voice communication unit (not shown) including an A/D converter and the like is supplied to the transmission data input line 26 of the 25 modem/baseband transmission signal processing unit 14.

 Assume that the radio signal characteristic extractor 5 identifies that the communication scheme of

modulator 18B are deactivated on the basis of the control signal S. As a result, the transmission data supplied to the transmission data input line 26 is input to the encoder 16A, and is input in turn to the communication protocol processing unit 17A and modulator 18A. The transmission signal output from the modulator 18A is supplied to the radio signal converter 22 via a transmission signal output line 27.

On the other hand, assume that the radio signal characteristic extractor 5 identifies that the communication scheme of the incoming radio signal is "B". In this case, the encoder 16B, communication protocol processing unit 17B, and modulator 18B are activated, while the encoder 16A, communication protocol processing unit 17A, and modulator 18A are deactivated on the basis of the control signal S. As a result, the transmission data supplied to the transmission data input line 26 is input to the encoder 16B, and is input in turn to the communication protocol processing unit 17B and modulator 18B. The transmission signal output from the modulator 18B is supplied to the radio signal converter 22 via the transmission signal output line 27.

As described in the second embodiment, the communication scheme switching process can be implemented without using any switches. The second embodiment can also obtain the same effects as those in the first embodiment.

(Third Embodiment)

FIG. 3 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio communication system according to the third embodiment of the present invention.

As shown in FIG. 3, the third embodiment is different from the first embodiment in that the radio signal converters 6 and 22 respectively comprise radio signal converters 6A and 22A compatible to communication scheme A, and radio signal converters 6B and 22B compatible to communication scheme B.

In this way, the radio signal converters 6 and 22 can be prepared in correspondence with communication schemes A and B.

(Fourth Embodiment)

FIG. 4 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio communication system according to the fourth embodiment of the present invention.

As shown in FIG. 4, the fourth embodiment is

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FIG. 5 is a block diagram showing the basic arrangement of an electronic apparatus with a radio communication function, which comprises a radio

communication system according to the fifth embodiment of the present invention.

As shown in FIG. 5, the fifth embodiment comprises a storage device 28. The storage device 28 stores reception signal processing softwares (demodulation softwares A and B, reception communication protocol processing softwares A and B, and decoding softwares A and B) as reception signal processing information in correspondence with communication schemes A and B. Likewise, the storage device 28 stores transmission signal processing softwares (encoding softwares A and B, transmission communication protocol processing softwares A and B, and modulation softwares A and B) as transmission signal processing information in correspondence with communication schemes A and B.

The storage device 28 receives the control signal S from the radio signal characteristic extractor 5. The storage device 28 selectively loads, based on the control signal S, the reception signal processing softwares (demodulation software A, reception communication protocol processing software A, and decoding software A) compatible to communication scheme A, or the reception signal processing softwares (demodulation software B, reception communication protocol processing software B, and decoding software B) compatible to communication scheme B. The loaded reception signal processing softwares are supplied to

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The advantage of such system is to be able to use common internal circuits of the modem/baseband

reception signal processing unit 7 and modem/baseband
transmission signal processing unit 14 when these
processing units 7 and 14 use, e.g., digital signal
processings (DSPs), programmable logical circuit
5 elements (PLDs), and the like. The storage device 28
stores DSP software, PLD circuit control information,
and the like compatible to different communication
schemes A and B, and when such software and information
are selectively loaded in accordance with the control
10 signal S, different communication schemes A and B can
be coped with.

(Sixth Embodiment)

The radio communication system according to the
present invention can be implemented by a semiconductor
15 integrated circuit device (LSI).

Such example will be described below as the sixth
embodiment.

FIG. 6 is a block diagram showing the basic
arrangement of a semiconductor integrated circuit
20 device for a radio communication according to the sixth
embodiment of the present invention.

As shown in FIG. 6, a radio communication system
can be basically divided into a radio communication
unit that processes high frequency signals, and a
25 modem/baseband unit that processes low frequency
signals. Hence, the radio communication system
according to the present invention can be implemented

by a high-frequency LSI 31 and low-frequency LSI 32.

The radio communication unit that processes high frequency signals is integrated on the high-frequency LSI 31. More specifically, the high-frequency LSI 31

5 comprises an input terminal 33 for receiving a radio signal (reception), a radio reception unit 1 for converting the input radio signal into a reception signal, an output terminal 34 for outputting the reception signal, a radio signal characteristic

10 extractor 5 for extracting a characteristic of the input radio signal, and identifying the communication scheme of the input radio signal from the extracted characteristic, an output terminal 35 for outputting a control signal S output from the radio signal

15 characteristic extractor 5, an input terminal 36 for receiving a transmission signal, a radio transmission unit 21 for converting the input transmission signal into a radio signal (transmission), and an output terminal 37 for outputting the converted radio signal.

20 The modem/baseband unit that processes low frequency signals is integrated on the low-frequency LSI 32. More specifically, the low-frequency LSI 32 comprises an input terminal 38 for receiving a reception signal, a modem/baseband reception signal

25 processing unit 7 for executing reception signal processes of the input reception signal, and converting it into reception data, an output terminal 39 for

outputting the reception data, an input terminal 40 for
receiving the control signal S, an input terminal 41
for receiving a transmission signal, a modem/baseband
transmission signal processing unit 14 for executing
5 transmission signal processes of the input transmission
data and converting it into a transmission signal, and
an output terminal 42 for outputting the transmission
signal. The high-frequency LSI 31 is electrically
connected to the low-frequency LSI 32 on, e.g., a
10 circuit board. In this manner, the radio communication
system according to the present invention can be
implemented using a semiconductor integrated circuit
device.

The low-frequency LSI 32 integrates circuits (9A,
15 10A, 11A, 16A, 17A, and 18A) compatible to
communication scheme A, and circuits (9B, 10B, 11B, 16B,
17B, and 18B) compatible to communication scheme B on a
single chip. Of course, circuits compatible to
communication schemes A and B may be separately
20 integrated on different chips.

However, when circuits compatible to communication
schemes A and B are integrated on a single chip, which
operates in synchronism with the control signal S from
the radio signal characteristic extractor 5, as in the
25 sixth embodiment, a consumption current reduction and
noise reduction can be achieved compared to a case
wherein those circuits are separately integrated on

different chips.

(Seventh Embodiment)

The seventh embodiment is another example of implementing the radio communication system according to the present invention using a semiconductor integrated circuit device (LSI).

FIG. 7 is a block diagram showing the basic arrangement of a semiconductor integrated circuit device for a radio communication according to the seventh embodiment of the present invention.

As shown in FIG. 7, the seventh embodiment is different from the sixth embodiment in that the radio communication system according to the present invention is integrated on a single LSI 43.

The LSI 43 comprises an input terminal 44 for receiving a radio signal (reception), a radio reception unit 1 for converting the input radio signal into a reception signal, a radio signal characteristic extractor 5 for extracting a characteristic of the input radio signal, and identifying the communication scheme of the input radio signal from the extracted characteristic, a modem/baseband reception signal processing unit 7 for executing reception signal processes of the input reception signal, and converting it into reception data, an output terminal 45 for outputting the reception data, an input terminal 46 for receiving transmission data, a modem/baseband

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(Eighth Embodiment)

The eighth embodiment is related to an example of radio signal characteristic extraction.

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its first to eighth embodiments. However, the present invention is not limited to these embodiments, and various modifications can be made within the scope of the gist of the present invention upon practicing the present invention.

For example, in the above embodiments, a portable phone has been exemplified as the electronic apparatus with a radio communication function. However, the present invention can be applied to any other apparatuses other than the portable phone. For example, the present invention can be applied to an electronic device which converts text data, still/moving image data, or the like in place of audio data into a radio signal, and transmits/receives the radio signal, an information terminal represented by a PDA (Personal Digital Assistant), and the like.

In the above embodiments, the arrangements compatible to two different communication schemes A and B have been exemplified. However, the number of communication schemes to be coped with is not limited to two, but the present invention can cope with three or more communication schemes.

The above embodiments can be practiced solely or in combination as needed.

An implementation of a radio communication system according to the present invention in the form of an LSI, which has been described with reference to, e.g.,

the sixth or seventh embodiment, is not limited to the first embodiment, but can be achieved by combining the second, third, fourth, or fifth embodiment (FIGS. 10 and 11).

5 Furthermore, the above embodiments include inventions in various stages, and the inventions in various stages can be extracted by appropriately combining a plurality of constituent requirements disclosed in the respective embodiments.

10 A radio communication system according to the present invention is different from a conventional dual mode radio communication system in that a received radio signal is identified before the received radio
15 signal is demodulated. A radio signal converter 6 and a modem/baseband reception signal processing unit 7 can be shared by different radio communication schemes. This can omit a circuit board arranged for each radio communication scheme, thereby simplifying the radio communication system. This makes it possible to
20 further downsize an electronic apparatus with a radio function.

 Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to
25 the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the

spirit scope of the general inventive concept as defined by the appended claims and their equivalents.